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FUCOIDS OR COPROLITES.

THE middle part of the Devonian section seen along the Mississippi River between Hampton in Illinois and Muscatine in Iowa consists of a shaly limestone, which is quite rich in fossils.[1] From this horizon I have for some time collected certain structures, which have a close resemblance to the fossils described by James Hall under the name *Spirophyton*,[2] and which occur in the rocks of the Hamilton period in New York. The fossils found here consist of flat cakes of calcareous material, from one to six millimeters in thickness and from five to thirty centimeters in width, intercalated among the layers of the rock, mostly lying parallel with these, and presenting an endless variety of forms (Figs. 1–8). The flat surfaces are bent in a succession of wave-like, crescentic, low and wide ridges, which become confluent and indistinct near the margin. Generally the widest ridges have a corresponding depression on the opposite side of the cake.

Much of Hall's description of *Spirophyton* is perfectly applicable to these fossils. Their substance is often "scarcely separable from the stony matrix," especially when the containing rock is unweathered. The wave-like ridges are "frequently not distinctly limited on the outer margin," which then appears to be continuous with a lamina in the rock (Fig. 8). In one instance there is a shallow groove following the edge of the cake on either side (Fig. 1) and resembling that seen in Hall's figure of *Spirophyton typum*.[3] The substance of the cake contains fragments of "small shells or fragments of shells." One of these is apparently a minute pteropod. I have, however, been unable to find any spiral or helical forms like that of *Spirophyton typum.* The nearest approach to it is a twisting of that end of the cake toward which the concave sides of the ridges are directed (Fig 7).

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[1] The part of the section to which is here referred is No. 4 in my paper, A Brief Description of the Section of Devonian Rocks, etc., published in the Journal of the Cin. Soc. of Nat. Hist., Vol. XIX, No. 3, pp. 93–95.

[2] Observations upon some Spiral-Growing Fucoidal Remains, etc., 16th Report on the State Cabinet of Nat. Hist., JAMES HALL, 1861–2, 76–83.

[3] HALL, loc. cit., Pl. II, Fig. 2.

There are several circumstances which point to a mechanical origin of these structures. The material of which they consist is a compact calcareous mass apparently identical to that of the surrounding rock. It is difficult to explain how this could have been introduced in such quantity and in such condition into the interior of a soft pulpy seaweed, and still have permitted the plant to leave a mold of both of its surfaces in the accumulating sediments. Another circumstance of similar significance is the indistinctness of the margins of some of the specimens. In their shapes, moreover, there is an indefinable lack of that uniformity of design which we are accustomed to find in organic forms. Unless certain ones are selected and others left out, classification on this basis seems impracticable. From Hall's description of the spiral-growing fucoids in the Devonian rocks in New York, it is evident that these also are variable in form, for he states that "the larger fronds not unfrequently present irregularities and distortions, both from unequal growth and from accident, evidently having been very flexible and easily disturbed," and he refers to some of the specimens as being "detached portions which have been distorted by pressure after their separation."

EXPLANATION OF PLATE VII.

FIG. 1. Dimensions: length, 19^{cm}; breadth 5.3^{cm}; average thickness, 2.5^{mm}.

FIG. 2. Dimensions: length, 12.5^{cm}; breadth 8^{cm} at the widest point; average thickness, 2^{mm}.

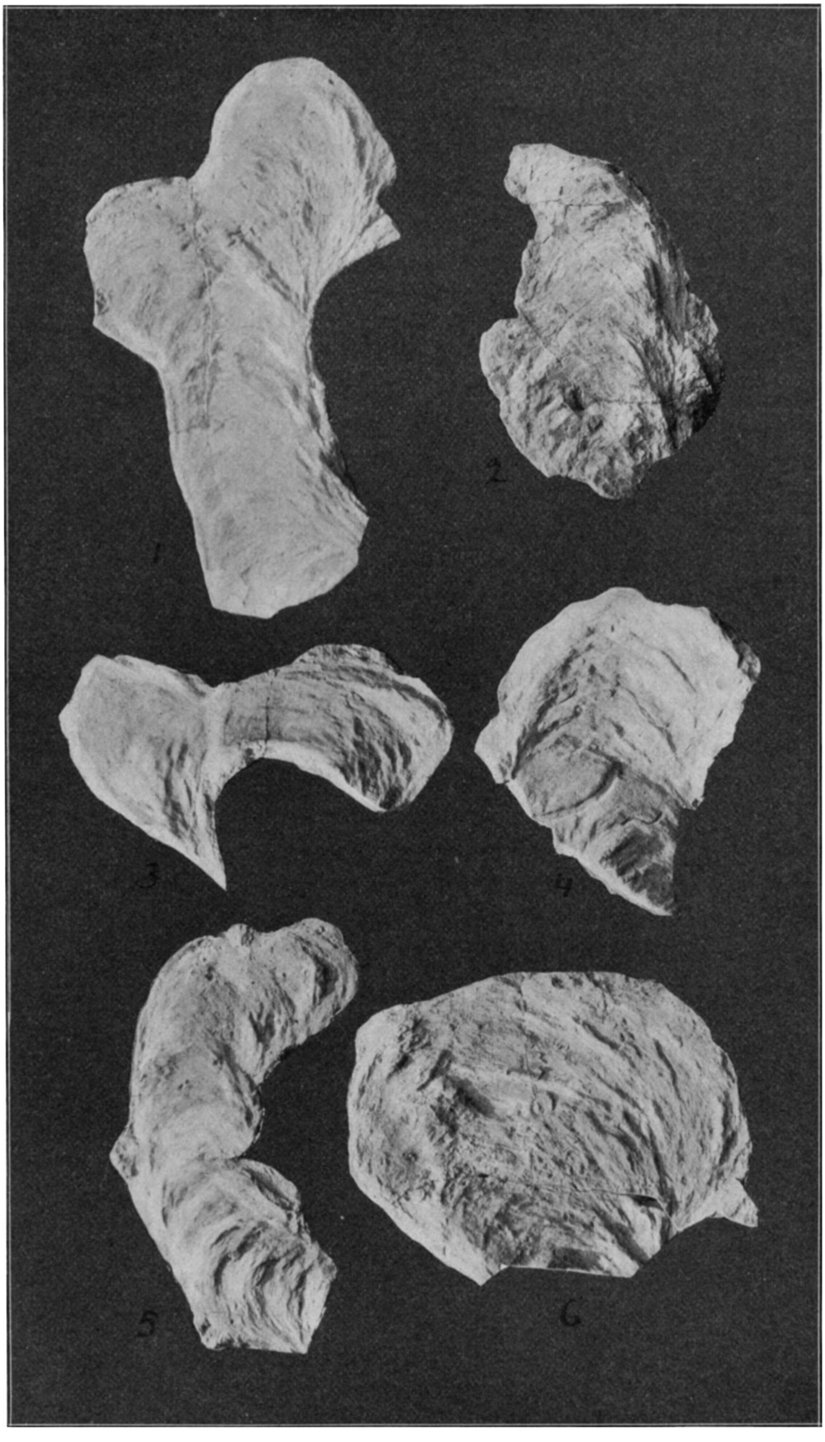
FIG. 3. Dimensions: greatest diameter, 13^{cm}; average thickness, 4^{mm}. Evidently fragmentary.

FIG. 4. Dimensions: length, 12^{cm}; greatest breadth, 10.5^{cm}; thickness from 6^{mm} to 2^{mm}.

FIG. 5. Dimensions: length, 16^{cm}; average breadth, 5^{cm}; average thickness, 4.5^{mm}.

FIG. 6. Dimensions: greatest diameter, 14^{cm}; average thickness, 4.5^{mm}. Fragmentary.

PLATE VII.



The general appearance of the western specimens is such as to suggest that they have been formed from flowing mud. In some instances the crescentic ridges overlap, as if the flow had run over on itself. Near the edges of the specimens planes of divisions are sometimes seen, which readily might be accounted for as planes of differential motion in moving mud, but which seem difficult to explain if the specimens be regarded as imprints or casts of sea-weeds.

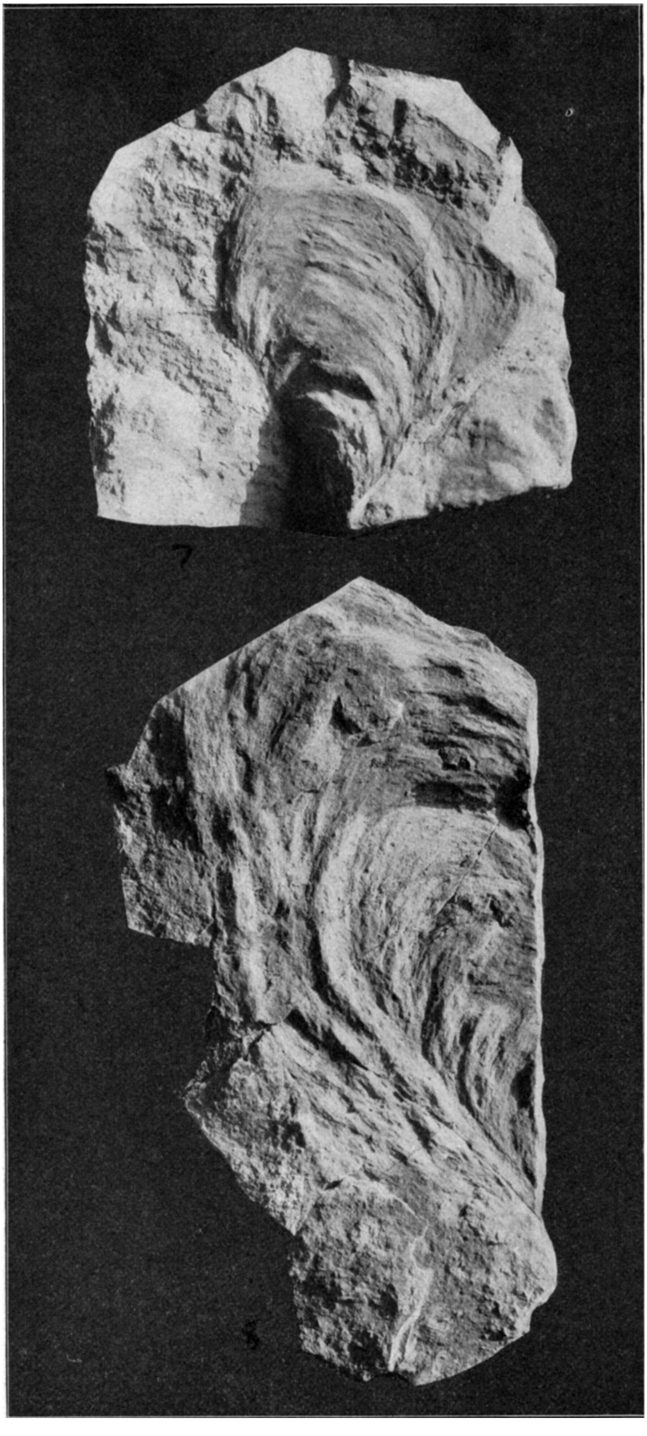
But the resemblance between these western specimens and *Spirophyton* is in general so perfect that there can hardly be any doubt that both have the same origin, and it is evident that the regular spiral frond of the latter, however rarely found, cannot have been produced except by the intervention of some organic agency. The quiet sea-bottom indicated by the nature of the sediments containing the fossils also preclude the possibility of the occurrence of mud-flow in the ordinary way under the conditions of deposition of the containing rock.

It seems, however, that cakes like these might be formed in just such situations from the voided contents of mud-eating animals, such as sea-cucumbers. These are known to burrow in the mud, far out in the sea, and to extract their food from such fragments of organic substance as they find in the ooze, mud, and sand with which they fill themselves, and which is afterward expelled by contractions of the visceral muscles. This may, no doubt, take place down in the mud as well as on the surface of the sea-bottom. If we suppose that the cakes have been formed in such a way, it is easy to account for their diversity of form—even when this takes on the complex twist of a spiral—and there will be no difficulty in explaining how it came about that they are molded from the same material as the surrounding matrix. A loose mud slowly forced out from a receding tube

EXPLANATION OF PLATE VIII.

FIG. 7. A specimen in the matrix. Length, 12^{cm}; breadth, 10^{cm}; thickness, 2^{mm}.

FIG. 8. Fragment of a large specimen cut by a joint in the rock obliquely, and confluent at the edge with a layer in the rock. Greatest length, 21.5^{cm}; breadth, 14^{cm}; average thickness, 4.5^{mm}.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can be made to settle in heaps which will have a noticeable resemblance to these peculiar fossils. This new interpretation of an obscure class of objects is given merely as an aid in their study. Though the holothurians are referred to as the animals most likely to produce coprolites of this kind, it is believed that any other mud-eating species of burrowing habits may just as well have done the work—soft animals, perhaps, that were sufficiently protected by their concealment in the ocean mud to render unnecessary any hard parts, which might have left less uncertain traces of their existence.

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